marconi instruments

TK 2373

FREQUENCY EXTENDER
for Spectrum Analyser TF 2370

Operating Manual

MP MASTER
MA23651

Frequency Extender TK 2373
for
110 MHz Spectrum Analyser TF 2370

Code No. 52373-900F

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MARCONI INSTRUMENTS LIMITED
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These chapters are contained in Vol. 2, Service Manual, which is available as an optional extra.

Note ...

Each page bears the date of the original issue or the code number and date of the latest amendment (Am. 1, Am. 2 etc.). New or amended material of technical importance introduced by the latest amendment is indicated by triangles positioned thus ▶ ..... ◀ to show the extent of the change. When a chapter is reissued the triangles do not appear.

Any changes subsequent to the latest amendment state of the manual are included on inserted sheets coded C1, C2 etc.

NOTES AND CAUTIONS

ELECTRICAL SAFETY PRECAUTIONS

This equipment is protected in accordance with IEC Safety Class 1. It has been designed and tested according to IEC Publication 348, 'Safety Requirements for Electronic Measuring Apparatus', and has been supplied in a safe condition. The following precautions must be observed by the user to ensure safe operation and to retain the equipment in a safe condition.

Defects and abnormal stresses

Whenever it is likely that protection has been impaired, for example as a result of damage caused by severe conditions of transport or storage, the equipment shall be made inoperative and be secured against any unintended operation.

Removal of covers

Removal of the covers is likely to expose live parts although reasonable precautions have been taken in the design of the equipment to shield such parts. The equipment shall be disconnected from the supply before carrying out any adjustment, replacement or maintenance and repair during which the equipment shall be opened. If any adjustment, maintenance or repair under voltage is inevitable it shall only be carried out by a skilled person who is aware of the hazard involved.

Note that capacitors inside the equipment may still be charged when the equipment has been disconnected from the supply. Before carrying out any work inside the equipment, capacitors connected to high voltage points should be discharged; to discharge mains filter capacitors, if fitted, short together the L (live) and N (neutral) pins of the mains plug.

Mains plug

The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action shall not be negated by the use of an extension lead without protective conductor. Any interruption of the protective conductor inside or outside the equipment is likely to make the equipment dangerous.

Fuses

Note that the supply fuse is connected in series with the brown (live) wire of the supply lead. If the equipment is connected to the supply via a

two-pin plug, it will be possible for the fuse to become connected to the neutral side depending upon the orientation of the plug in its socket. In these circumstances certain parts of the instrument could remain at supply potential even after the fuse has ruptured.

To provide protection against breakdown of the supply lead, its connectors, and filter where fitted, an external supply fuse (e.g. fitted in the connecting plug) should be used in the live lead. The fuse should have a continuous rating not exceeding 6 A.

Make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of mended fuses and the short-circuiting of fuse holders shall be avoided.

Chapter 1

GENERAL INFORMATION

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1 Frequency extender, type TK 2373 1

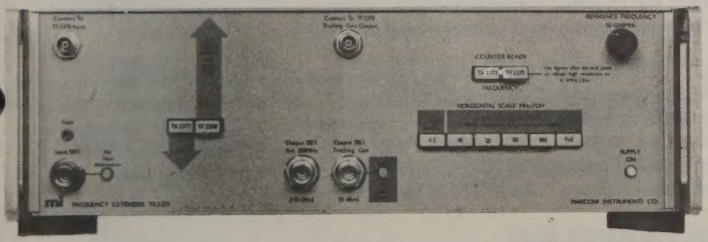

Fig. 1 Frequency extender type TK 2373.

INTRODUCTION

1. TK 2373 is a heterodyne converter that enables r.f. spectra up to 1.25 GHz to be displayed by Marconi Instruments' Spectrum Analyser type TF 2370. The frequency extender is essentially a system of oscillators, mixers and filters that converts input frequencies in the range 50 MHz to 1.25 GHz to an output frequency suitable for display on TF 2370. When used with the extender unit, the spectrum analyser is tuned to a centre frequency of 80 MHz for optimum performance and the analyser is used in the normal manner. The oscillator frequencies in the extender are used also to convert the spectrum analyser's tracking generator output up to the frequency to which the extender is tuned, and so provide an extended tracking generator output. The extender's tracking generator circuit also provides a signal for the frequency counter in TF 2370, so that the counter covers the extended input frequency range.

2. Wider sweeps are available when the extender is in use. They are 1 GHz, 500 MHz, 200 MHz, and 100 MHz wide, which correspond to horizontal scales of 100 MHz/div., 50 MHz/div., 20 MHz/div., and 10 MHz/div. as well as the narrower sweeps available from TF 2370. For any of these sweeps, the reference frequency can be set anywhere in the range 50 MHz to 1.25 GHz, provided that the sweep does not extend outside this range. A fixed 50 MHz - 1.25 GHz full band sweep corresponding to 120 MHz per division is also provided.

3. Filter resolution is 50 kHz for horizontal scales 10 MHz/div. or more. Sweep speed for these horizontal scales is approximately 1 ms/MHz. For narrower sweep dispersions, the spectrum analyser controls indicate the filter bandwidth and sweep speed.

4. Two umbilical connector assemblies link the rear panel connectors with both units of the spectrum analyser. The frequency extender has BNC sockets on its front panel which connect via short coaxial links to the r.f. input and tracking generator output of the spectrum analyser. RF input and tracking generator output connections for the frequency extender are made via the front panel N-type sockets.

5. TK 2373 may be used with any Marconi Instruments' 110 MHz Spectrum Analyser type TF 2370 or type TF 2370/1. An initial adjustment of the extender's front panel gain control compensates for the small loss of gain when the 75 Ω TF 2370/1 is used with a TK 2373 extender. The performance characteristics are otherwise unaffected by the difference in input impedance. See Chap. 3, page 8 for details.

PERFORMANCE DATA

6. Amplitude measurement

Input impedance : 50 Ω nominal (N-type socket)

Input v.s.w.r. :	Less than 1.5:1 with at least 10 dB of input attenuation.
Maximum input :	+30 dBm (7.1 V r.m.s.) for 5 minutes, with at least 10 dB of input attenuation. +25 dBm (4.0 V r.m.s.) with at least 10 dB of input attenuation. +20 dBm continuous with no input attenuation. (Front panel lamp is illuminated when input attenuation is zero).
Vertical scale range :	+30 dBm to -159 dBm at 10 dB/div. +30 dBm to -109 dBm at 1 dB/div.
Frequency response relative to 200 MHz :	For wide sweeps from 10 MHz/div. to 100 MHz/div. and full sweep : ±1.0 dB with -10 dBm top of screen display (1 dB/div.). (TF 2370 tuned to 80 MHz ±2 MHz) For narrow sweeps less than 10 MHz/div.: ±1.0 dB + TF 2370 specification with -10 dBm top of screen display (1 dB/div.).
Vertical scale ranging accuracy :	±1 dB per 10 dB step Cumulative error $<$ ±1.5 dB.
Spurious responses :	70 dB below a signal at a level of -40 dBm at input mixer of TF 2370.
Intermodulation display :	-70 dB (two tone test) with signals at -40 dBm to TF 2370 input mixer and 500 Hz apart.
Average noise level :	Between 50 MHz and 1.25 GHz with 50 Hz filter selected : Less than -125 dBm with counter 'OFF'.
Tracking generator leak :	Between 50 MHz and 1.25 GHz with 50 Hz filter selected : Less than -105 dBm with counter 'ON'.
Residual responses :	Between 50 MHz and 1.25 GHz : Less than -100 dBm measured at input socket of TF 2370.

7. Calibrator

Output impedance :	50 Ω nominal (N type socket).
Frequency :	200 MHz ±400 Hz.
Amplitude :	-10 dBm ±0.3 dB.

8. Tracking generator output : This enables the transfer characteristic of any network to be measured over a dynamic range of up to at least 90 dB.

Output impedance :	50 Ω nominal (N type socket).
Output v.s.w.r. :	1.5:1.
Frequency :	50 MHz to 1.25 GHz within 2 Hz of tuned frequency.
Amplitude :	0 dBm ±1 dB at 200 MHz.
Frequency response :	±1 dB with respect to the 200 MHz level between 50 MHz and 1.25 GHz.

9. Frequency measurement

Frequency range :	50 MHz to 1,25 GHz.
Sweep widths :	50 MHz to 1.25 GHz (full sweep). 10 MHz/div. 20 MHz/div. 50 MHz/div. 100 MHz/div. (Narrower sweeps set by TF 2370)
Sweep speed :	As determined by TF 2370.
Frequency accuracy :	See counter below.
Resolution :	50 kHz on sweeps selected by extender, others determined by TF 2370.
Band mask :	Limits TF 2370 viewing to within the approximate frequency range 55 MHz to 105 MHz, when the extender is in operation.

10. Counter : The frequency displayed on the TF 2370 counter is either the TF 2370 frequency or the TK 2373 frequency as selected by a front panel switch.

Accuracy : See TF 2370 manual.

11. Power requirements

AC supply : When linked to TF 2370, a.c. supply to TK 2373 is interrupted by use of TF 2370 supply switch. Supply to TF 2370 is via the supplied a.c. lead, (see supplied accessories).

Supply voltage :	200 to 250 V or 100 to 130 V a.c. at any frequency between 45 Hz and 440 Hz.
Power requirement :	Consumption approximately 110 VA. With spectrum analyser, total consumption is 300 VA.

12. Safety regulations : Complies with IEC 348 and BS4143 safety requirements.

13. Radio frequency interference : This equipment conforms with the requirements of EEC Directive 76/889 as to limits of r.f. interference.

14. Environmental

Rated range of use :

Temperature :	0°C to 40°C.

Conditions of storage and transport :

Temperature :	-40°C to 70°C.
Humidity :	Up to 90% relative humidity.
Altitude :	Up to 2500 m (pressurized freight at 27 kN/m^2 differential, i.e. 3.9 lbf/in^2).

Limit range of operation :

Temperature :	0°C to 55°C.

15. Dimensions and weight :

Height	Width	Depth	Weight
156 mm (6.14 in)	453 mm (17.83 in)	516 mm (20.31 in)	19 kg (42 lb)

ACCESSORIES

16.

Supplied	Code no.
Operating manual	H 52373-900F Vol. 1
Supply lead for TF 2370	43129-325A
Connector assembly (umbilical)	43169-015E
Connector assembly (umbilical)	43169-016U
Extender board	44828-323S
Board extractor	41148-605K
Plastic cover	37490-180L

Supplied	Code no.
Front panel cover (with stowage for leads)	41690-226Y
Spare fuse kit	46883-399C
Coaxial links (2)	43129-306G
Conversion kit (2 printed circuit boards; see Chap. 2 para. 7)	46883-375Z

17. Optional

Service manual	H 52373-900F Vol. 2
Rack mounting kit	54127-301P
Signal injector assembly	44990-311N
Lead assemblies :	
Umbilical extender, for PLSE	43129-422M
Umbilical extender, for PLSD	43129-423C
Long coaxial links (2)	43129-424R
SMA to SMA extender for internal connections (2)	43129-425B
Primary pack	37136-479W

Chapter 2

INSTALLATION

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1 Unpacking and repacking
3 Mounting arrangements
4 Rack mounting instructions
5 Connection to mains supply
7 Modification to spectrum analyser

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UNPACKING AND REPACKING

1. Retain the containers, packing materials and the packing instruction note (if included) in case it is necessary to reship the unit.

2. If the unit is to be returned for servicing, attach a label indicating the service required, type or model number (on rear label), serial number and your return address. Pack the unit according to the instructions given below. Refer to the drawing on page 3.

(1) Place the bottom U-section pad in the container.

(2) Place the plywood load spreader in the container on the bottom U-section pad.

(3) Put the unit inside its polyethylene cover and lower it into the container so that the front and rear of the unit are cushioned by the ends of the bottom U-section pad and the unit's mounting feet are located in the corner notches of the load spreader.

(4) Place the top U-section pad on the unit and tuck down the padded side flaps so that the sides of the unit are cushioned.

(5) Wrap the container in waterproof paper and secure it with adhesive tape.

(6) Mark the package FRAGILE to encourage careful handling.

Note ...

If the original container or materials are not available, use a strong double-wall carton packed with a 7 to 10 cm layer of shock absorbing material around all sides of the unit to hold it firmly. Protect the front panel controls and the rear panel with plywood load spreaders.

MOUNTING ARRANGEMENTS

3. The frequency extender has been designed to be bench or rack mounted underneath the TF 2370 Spectrum Analyser. Always disconnect all three units before attempting to move or lift them. The height of a TF 2370 Spectrum Analyser and TK 2373 Frequency Extender combination is 461 mm, 18.15 in.

Rack mounting instructions

4. The unit is normally supplied ready for bench mounting. A rack mounting kit, consisting essentially of a pair of mounting brackets is available as an optional accessory. To fit the brackets proceed as follows :-

(1) Remove the unit's feet, after temporarily removing the unit's bottom cover.

(2) Peel off the trim strip in the recess of each of the front panel handles.

(3) Fit the brackets in these recesses and secure by fitting the M4 screws provided into the tapped holes.

(4) If the rack is likely to be subjected to violent movement or vibration, slides or runners must be fitted to the rack to give support to the rear of the instrument. With the side panels removed, M4 tapped holes will be revealed which can be used for this purpose.

Connection to mains supply

5. Before connecting the mains supply, check that the rear panel voltage selector is correctly set. If it is necessary to alter the setting, remove the plastic cover and align the arrow on the shorting bar with the mains supply voltage, and check that the setting is the same as that on the spectrum analyser. Refit the voltage selector plastic cover.

6. Check that the supply fuse is the recommended rating for the supply voltage to be used. For 100 V to 125 V, use 2 A time lag and for 200 V to 250 V use 1 A time lag.

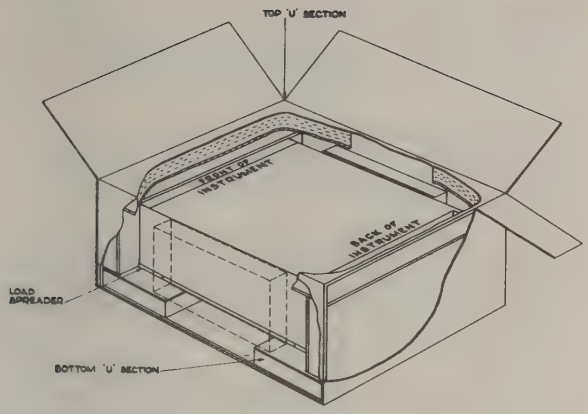

Fig. 1 TK 2373 Primary pack.

Modification to Spectrum Analyser

7. To enable the frequency extender operation to be simplified the TF 2370 Spectrum Analyser has been modified by changes made to two of the upper unit plug-in printed circuit boards, which provide integration of the logic control for the two instruments and enables operating frequencies of the extender unit to be displayed on the TF 2370 frequency counter. The modifications do not affect the operation of the analyser when used without an extender unit, and they have been embodied in instruments of recent manufacture.

8. For spectrum analysers with serial numbers 164101-001 to 164126-050 and 151001-001 to 151022-035, proceed with the modification as follows :

(1) Disconnect the mains supply.

(2) Unscrew the four M4 screws located on the sides of the display unit and remove the lid.

(3) Locate the two printed circuit boards AG4 and AF1. Looking from the front of the instrument; these boards are first and sixth from the right respectively. Each board is marked with a type number near its top edge and each board location is marked on the flange of the metal housing of the plug-in board assembly. If the boards already fitted are types AF1D and AG4D, proceed to (6).

(4) Remove the AF1 and AG4 boards which are to be replaced, using a suitable extractor such as MI part No. 41700-048.

(5) Insert the supplied replacement board AF1D from the conversion kit 46883-375Z, ensuring that the component side is to the left.

(6) Establish whether the TF 2370 provides an x-y output facility. If provided, there will be a 15-way socket marked SKTR on the rear of the display unit mounted alongside the supply voltage selector panel.

For spectrum analysers providing an x-y output, the two solder tags marked LK1 on the replacement printed circuit board AG4D should be connected together; similarly the tags marked LK2 should be bridged. The replacement boards will normally be supplied with these links set as above for use in an analyser with x-y output.

If the spectrum analyser does not have x-y output, cut the links leaving the tags open-circuited.

(7) With the links LK1 and LK2 appropriately set, fit the replacement AG4D printed circuit board.

(8) Reassemble the instrument.

Chapter 3

OPERATION

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Note ...

References to the titles of controls on the frequency extender are printed in capital letters.

EXTERNAL FEATURES

Front panel

1. Refer to front panel diagram Fig. 1 at the end of this chapter.

(1) OUTPUT TO TF 2370 connector, 50 Ω BNC type. Connects the extender's output via a short coaxial link to the spectrum analyser's input.

(2) GAIN control. Allows the level of the output signal to the spectrum analyser to be accurately calibrated. It enables gain adjustment to compensate for the small loss when the extender is used with TF 2370/1, a 75 Ω version of the TF 2370 Spectrum Analyser.

(3) Selector switches for extender or spectrum analyser input. Press USE TK 2373 to display signals in the range 50 MHz to 1.25 GHz. Press USE TF 2370 to display signals in the range 30 MHz to 110 MHz. When USE TK 2373 is selected, N-type connectors (10) and (13) are used. When USE TF 2370 is selected, connect the item under test directly to the BNC input and tracking generator output connectors on the spectrum analyser.

(4) INPUT FROM TF 2370 connector, 50 Ω BNC type. Connects the spectrum analyser's tracking generator output to the extender's tracking generator input.

(5) Selector switches for counter input. When the extender is in use with USE TK 2373 selected, press COUNTER READS TK 2373 to display the tuned frequency of the extender. When COUNTER READS TF 2370 or USE TF 2370 are selected, the counter displays the tuned frequency of the spectrum analyser only.

(6) REFERENCE FREQUENCY control. When horizontal scale FULL is selected, the REFERENCE FREQUENCY control is inactive. When horizontal scales from 10 MHz to 100 MHz per division are used, this ten-turn potentiometer is used to set the reference frequency continuously from 50 MHz to 1.25 GHz. For horizontal scales of 5 MHz/div.or less, this control sets the reference frequency to phase-locked intervals of 10 MHz in the range 50 MHz to 1.25 GHz. In all cases, finer reference frequency adjustments may be made using the spectrum analyser reference frequency controls. For lowest noise and most stable operation, take care when setting this control to avoid the less stable transition areas encountered between phase-locked frequency steps.

(7) SUPPLY ON warning lamp. The power supply is switched on and off from the spectrum analyser on/off switch.

(8) HORIZONTAL SCALE selector. This assembly of six push-button switches allows selection of five horizontal scales : 10 MHz, 20 MHz, 50 MHz and 100 MHz per horizontal graticule division, or FULL, where the spectrum from 50 MHz to 1.25 GHz is displayed. The sixth horizontal scale push-button, ≤5 MHz/div, switches horizontal scale control to the spectrum analyser's front panel, so that horizontal scales of 5 MHz or less per division may be displayed. For horizontal scales of 10 MHz per division or more, a 50 kHz filter is selected in the spectrum

analyser. Sweep speeds for the horizontal scales from 10 MHz to FULL are : 0.1 s, 0.2 s, 0.5 s, 1 s, 1 s. Filter bandwidths and sweep speeds for horizontal scales of 5 MHz or less per division are selected by the spectrum analyser's front panel controls.

(9) NO BAND MASK warning lamp. Indicates that the tracking generator and hence the band mask are not operating. This occurs when there is no input from the spectrum analyser's tracking generator output, for example when the spectrum analyser's tracking generator has been switched off at the counter on/off switch when making low level measurements.

(10) Extender TRACKING GENERATOR OUTPUT connector, 50 Ω N type.

(11) STANDARD OUTPUT. 200 MHz square wave at -10 dBm from 50 Ω N type connector. This output is phase-locked to the spectrum analyser's 10 MHz standard, and has an accuracy better than 400 Hz in 200 MHz. Greater accuracy may be obtained by feeding the external standard input of the spectrum analyser from a reference frequency source whose accuracy is better than 1 part in 10^7.

(12) NO INPUT ATTENUATION warning lamp. Indicates that the extender's r.f. attenuator, which operates remotely from the spectrum analyser's 10 dB/div. vertical scale push-buttons, is switched to 0 dB, i.e., no input attenuation. When this lamp is lit, do not allow the continuous input level to exceed +20 dBm and note that the extender's input v.s.w.r. is not specified for this setting of its r.f. attenuator. Operation of the 1 dB/div.i.f. attenuator push-buttons changes neither the extender's input v.s.w.r. nor the limit of its allowable input level.

(13) INPUT connector, 50 Ω N type. For input frequencies from 50 MHz to 1.25 GHz.

Rear panel

2. Refer to the rear panel diagram Fig. 2 at the end of this chapter.

(1) Supply fuse. 1 A slow acting for 200 V to 250 V supply, or 2 A for 100 V to 130 V supply.

(2) SUPPLY TO TF 2370 output connector, 3 pin. Connects mains supply via mains connector assembly 44129-325A to the TF 2370 mains input connector.

(3) Supply voltage selector. The shorting bar selects the correct mains transformer tapping to suit the mains supply voltage.

(4) Interconnecting sockets. These accept the umbilical connector assemblies, which carry control signals between the spectrum analyser and its frequency extender. For illustration showing connection, see Fig. 3(a).

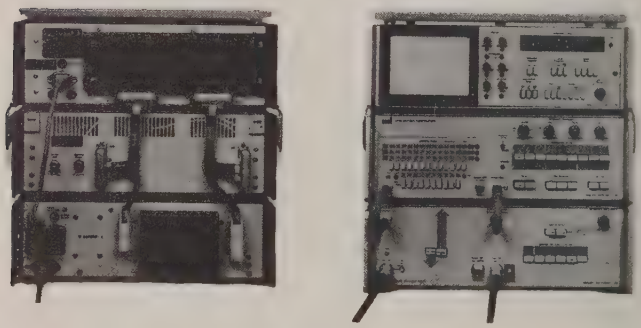
(5) SUPPLY plug, 3-pin, for mains supply lead.

PREPARATION FOR USE

Connections

3. When the spectrum analyser is used with the frequency extender, the mains supply to the spectrum analyser is looped through the extender. The spectrum analyser's on/off switch remotely controls a relay in the extender that connects the mains to the power supply circuit.

4. Refer to Fig. 3(a) which shows the connections between the rear panels of the spectrum analyser and extender.



(a) (b)

Fig. 3 Spectrum analyser with frequency extender
(a) Showing rear panel connections
(b) Showing front panel connections.

(1) Connect the short mains lead 43129-325A (supplied) between the mains input plug on the rear panel of the display unit to the 3-pin socket near the top left-hand corner of the frequency extender's rear panel.

(2) Use the spectrum analyser's mains lead to connect the frequency extender to the mains supply.

(3) With umbilical connector assembly 43169-016U, connect socket SKB on the spectrum analyser display unit to socket SKD on the r.f. unit and the left-hand multi-pin connector on the frequency extender's rear panel.

(4) With umbilical connector assembly 43169-015E, connect socket SKC to SKE on the spectrum analyser and to the right-hand multi-pin connector on the frequency extender's rear panel.

5. Refer to Fig. 3(b) which shows the connections between the front panels of the spectrum analyser and extender.

(1) Link the spectrum analyser and extender with the BNC connector assemblies 43129-306G (supplied).

OPERATING PROCEDURE

Introduction

6. The frequency extender's principles of operation and hence its controls, are similar to those of the r.f. section of the spectrum analyser. For easy operation of the extender, first be familiar with operating the spectrum analyser and, if necessary, refer to its instruction manual when reading these instructions. The measurement techniques explained in the spectrum analyser's operating instructions consist mainly of the manipulation of the display unit controls which change the store, display and counter modes. These techniques are unchanged when the spectrum analyser is used with its frequency extender. The operating procedures in this chapter explain techniques that are significantly different from those given in the spectrum analyser instruction manual.

First time operating procedure

7. Switch on, using the spectrum analyser's SUPPLY ON switch. A faint click may be heard as the remote-controlled power supply switch in the frequency extender is energized.

8. Set the frequency extender controls as follows :

USE : TK 2373
COUNTER READS : TF 2370 FREQUENCY
HORIZONTAL SCALE : FULL

9. Set the spectrum analyser controls as follows :

Reference frequency : centre
Counter frequency : past centre

Sweep mode : auto
Vertical scale range : 10 dB/div.
Display : high defn.
Vertical scale : -10 dBm

10. Tune the 0-110 MHz reference frequency control on the spectrum analyser to obtain a counter reading of approximately 80 MHz. Note that the display consists of low-level noise and a blanked portion at the left of the display indicating the lower frequency limit of the extender, as shown in Fig. 4.

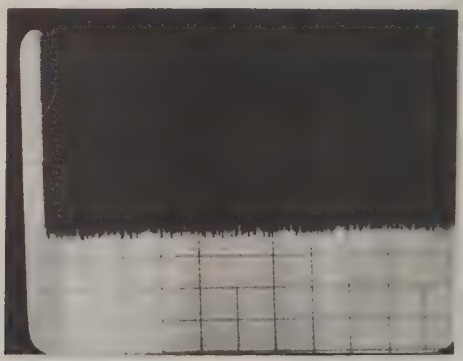


Fig. 4 Spectrum analyser display with 50 MHz blanking.

11. Select COUNTER READS : TK 2373

The counter now reads approximately 650 MHz, the centre frequency of the full sweep.

12. Connect the 200 MHz standard output to the frequency extender's input. A comb display of the 200 MHz standard signal and its harmonics (similar to Fig. 5), now appears on the screen.

13. Select HORIZONTAL SCALE 100 MHz/DIV, note that the counter reading has changed to the new centre frequency of the sweep, and that this frequency can be varied and the display and blanked portion of the screen correspondingly shifted, by using the REFERENCE FREQUENCY CONTROL.

14. Select narrower HORIZONTAL SCALE dispersions and note the expansion of the display. When the $\leq$ 5 MHz/div HORIZONTAL SCALE button has been selected the band mask will appear. The band mask begins approximately 25 MHz above and below 80 MHz and blanks the display outside

these limits, see Fig. 6. The band mask is an electronically generated visual tuning indicator intended to assist you to keep the spectrum analyser tuned to 80 MHz. Note that the REFERENCE FREQUENCY control changes the display and counter frequency in 10 MHz steps. Observe how finer variations are made using the spectrum analyser's reference frequency controls.

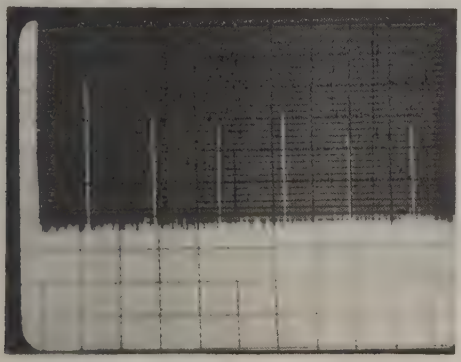


Fig. 5 200 MHz standard signal display.

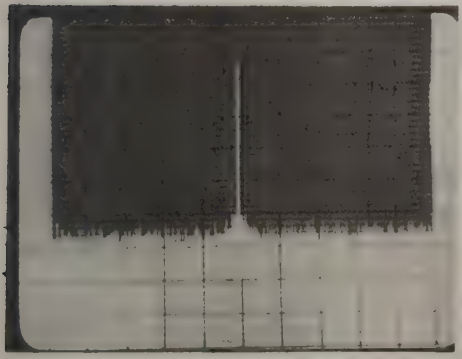


Fig. 6 Display with band mask.

High resolution frequency measurement

15. Counter resolution using the extender is 10 Hz, but by using the following technique, frequency measurements may be resolved to 1 Hz.

16. Identify the signal whose frequency is to be measured, using a convenient horizontal scale. Expand the horizontal scale to 5 MHz/div. or less. The frequency extender is then in the phase-locked mode. Retune the spectrum analyser's and extender's reference frequency controls as necessary to maintain the signal under observation on the reference frequency datum, or if the bright line is being used as a frequency cursor, it should be repositioned as necessary. With COUNTER READS TK 2373 selected, read the frequency on the counter display. This reading gives the frequency to which the extender and analyser combination is tuned resolved to 10 Hz. Press COUNTER READS TF 2370, and read the counter frequency. This reading gives the frequency to which the spectrum analyser is tuned, resolved to 1 Hz. Use the whole number part of the display in the COUNTER READS TK 2373 mode, together with the decimal part of the display when in the COUNTER READS TF 2370 mode, to achieve a frequency resolution of 1 Hz.

Example :

COUNTER READS TK 2373	:	0123.45679
COUNTER READS TF 2370	:	083.456789
Actual frequency	:	123.456789 MHz

Using the frequency extender with a TF 2370/1 75 Ω Spectrum Analyser

17. The frequency extender should be connected to the TF 2370/1 in the normal way, as shown in Fig. 3 of this chapter, using the supplied 50 Ω coaxial leads and umbilical connector assemblies. The BNC connectors on the 50 Ω coaxial leads are dimensionally compatible with the spectrum analyser's input connectors.

18. First calibrate TF 2370/1 using its 10 MHz standard output signal. Then calibrate TK 2373 using its 200 MHz standard output and GAIN control as indicated on page 2 and page 9.

19. Fig. 7(a) shows a 75 Ω source feeding a TF 2370/1 Spectrum Analyser with a signal that produces a -10 dBm power level in the input load. This is what happens when the TF 2370/1 is calibrated from its 10 MHz standard output. Note that the e.m.f. source voltage is 490 mV pk-pk and the voltage across the load is 245 mV pk-pk. Fig. 7(b) shows TK 2373 with its 50 Ω source impedance feeding into TF 2370 with its 50 Ω input impedance. A source e.m.f. of 400 mV pk-pk is required to produce -10 dBm

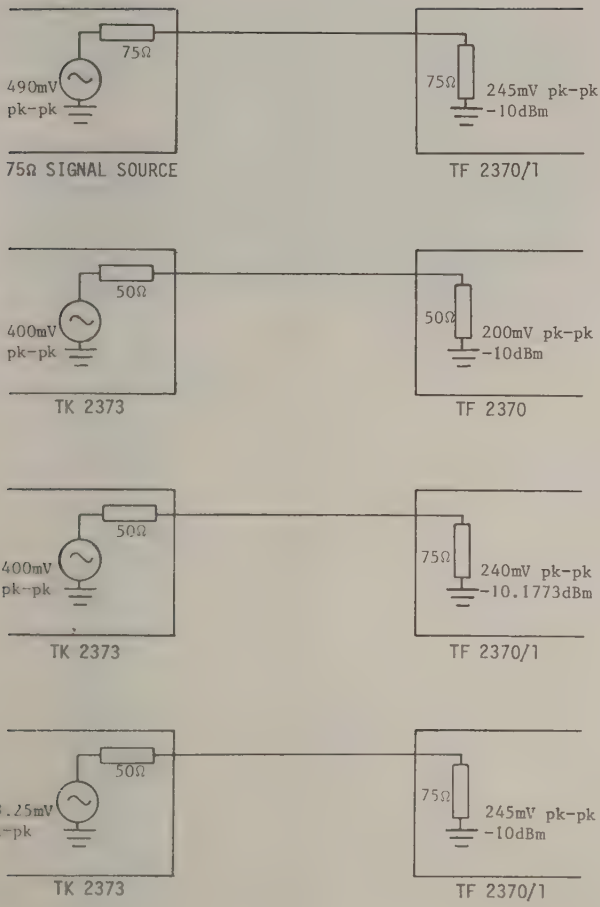


Fig. 7 Signal levels with 75 Ω Spectrum Analyser.

in the 50 Ω load. But when as in Fig. 7(c) TK 2373 is connected to TF 2370/1, the distribution of the e.m.f. across the source and load impedances results in 240 mV across the load impedance which corresponds to -10.1773 dBm. So in order to calibrate TF 2370/1 when it is connected to TK 2373, adjust the GAIN control - refer to page 2 and page 9 - so that the output of TK 2373 is slightly increased as in Fig. 7(d) and a signal level of -10 dBm is indicated in the display of TF 2370/1.

20. There is a slight reduction of input power to the frequency extender's tracking generator circuit due to the difference in impedance between the tracking generator output of TF 2370/1 and the tracking generator input of TK 2373. However, the automatic level control circuit which maintains the tracking generator output of TK 2373 at a constant level, fully compensates for this difference in level. Therefore, provided that the TK 2373 Tracking Generator is operated into a 50 Ω load, the output is still -10 dBm when TK 2373 is used with TF 2370/1.

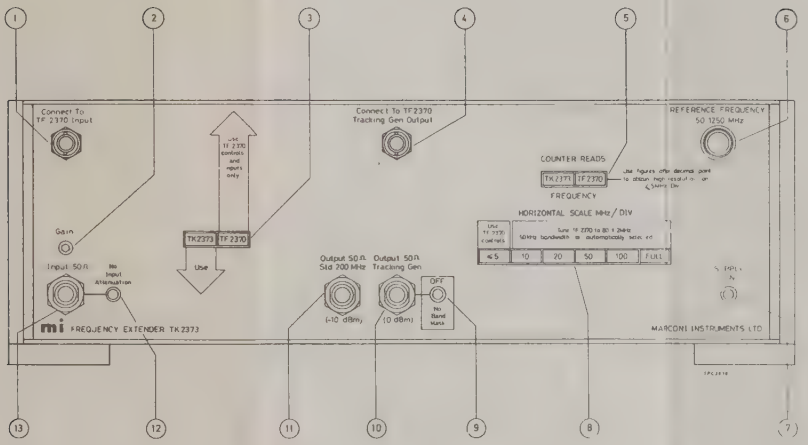


Fig. 1 Front panel controls and connectors

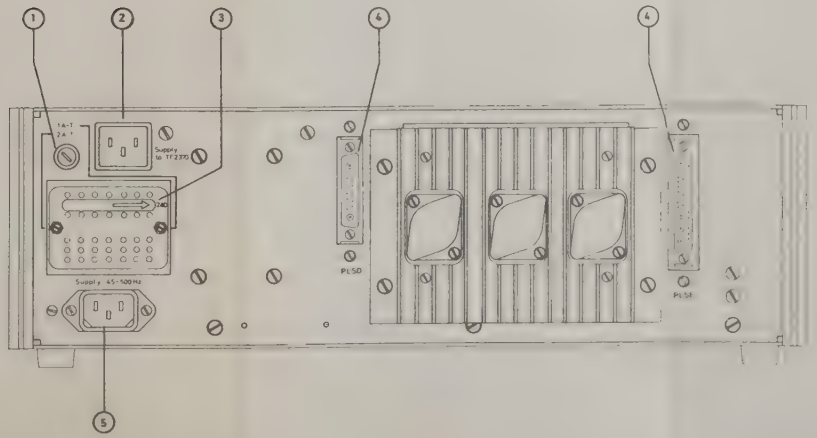
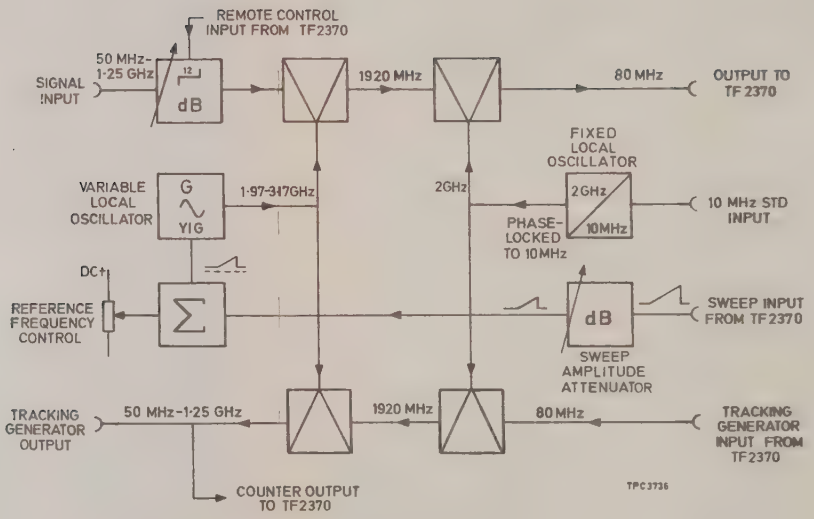


Fig. 2 Rear panel



Simplified block diagram

Chapter 4-1

BRIEF TECHNICAL DESCRIPTION

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1 System description
2 Input attenuator
3 Receiver
9 10 MHz reference oscillator
10 200 MHz standard output generator
11 Fixed local oscillator
12 Variable local oscillator
14 10 MHz phase-locked loop
15 Tracking generator
17 Output to counter
18 Band mask

Simplified block diagram - See facing page.

SYSTEM DESCRIPTION

1. This chapter summarizes the operation of the TK 2373 Frequency Extender. Refer to the block diagram on the facing page.

Input attenuator

2. When the spectrum analyser is used with its frequency extender, the spectrum analyser's input attenuator is not used and instead, input signals are attenuated in the extender's attenuator. The extender's input attenuator is similar to that used in the spectrum analyser, except that the range of frequencies for which it gives uniform attenuation is 50 MHz to 1.25 GHz. Binary control signals, derived from the spectrum analyser's push-button vertical scale selector, operate the extender's input attenuator in four stages to give up to 120 dB of attenuation in 10 dB steps. The 1 dB attenuator operates as usual, attenuating signals in the i.f. stages of the spectrum analyser.

Receiver

3. The frequency extender converts input signals in the frequency range of 50 MHz to 1.25 GHz by a heterodyne process to provide output signals in

the range 55 MHz to 105 MHz suitable for display on the TF 2370 Spectrum analyser. It is tuned synchronously by the spectrum analyser display sweep to produce a display of input amplitude variation with respect to input frequency. To produce this display, a ramp waveform, generated in the spectrum analyser is used to control the display read-in sweep and the frequency sweep of the spectrum analyser's local oscillator tuning system. When the frequency extender is in use, this ramp waveform is diverted to the frequency extender where it controls the extender's local oscillator tuning system. The control ramp is attenuated according to the setting of the extender's horizontal scale push-buttons and its d.c. level is shifted according to the reference frequency control setting. This waveform is used to sweep a local oscillator between two frequencies in the range 1.97 GHz to 3.17 GHz.

4. The output of this oscillator is mixed with the input signal to produce an i.f. signal. The i.f. stage includes a band-pass filter with a centre frequency of 1.92 GHz. If the variable local oscillator sweeps from 1.97 GHz to 3.17 GHz, an input frequency band is tuned from 50 MHz to 1.25 GHz.

5. A further heterodyne stage mixes the i.f. signal with a fixed frequency local oscillator signal of 2 GHz to produce an output signal in the frequency range of the spectrum analyser. The spectrum analyser is tuned nominally to 80 MHz, though the i.f. bandwidth is sufficient to permit the spectrum analyser to be tuned up to 25 MHz away from 80 MHz, i.e., from 55 MHz to 105 MHz. (A band mask covers the display when the spectrum analyser is tuned outside these limits, see para. 18.)

6. Changes in both the extender's local oscillator frequency and the tuning of the spectrum analyser affect the tuning of the input to the frequency extender. The frequency translation of the extender may be expressed as follows :

$$f_{in} = f_{l.o.} + f_{s.a.} - 2 \text{ GHz}$$

Where

f_{in} = input frequency of extender (from 50 MHz to 1.25 GHz).

$f_{l.o.}$ = extender local oscillator frequency (from 1.97 GHz to 3.17 GHz).

$f_{s.a.}$ = input frequency tuning of spectrum analyser (from 55 MHz to 105 MHz).

7. When the horizontal scale is 5 MHz/div. or less, the local oscillator control ramp is not fed to the frequency extender's local oscillator, but instead sweeps the local oscillator system of the spectrum analyser. The spectrum analyser sweeps the required frequency band, which will be up to 50 MHz wide in order to produce a 5 MHz/div. display. The reference frequency of this sweep depends on the settings of both the frequency extender's and the spectrum analyser's reference frequency controls.

The frequency extender's reference frequency control operates over the range 50 MHz to 1.25 GHz, but in this mode does so in 10 MHz phase-locked increments. Finer changes in reference frequency are made using the spectrum analyser's reference frequency controls.

8. For sweep dispersions of 10 MHz/div. or more, the bandwidth of the spectrum analyser is 50 kHz. For narrower sweeps, which are selected from the spectrum analyser's horizontal scale push-button switches, the filter bandwidths are those marked on the front panel near the horizontal scale push-buttons.

10 MHz reference oscillator

9. The 10 MHz standard frequency generated in the spectrum analyser is connected to the frequency extender via the umbilical connector assembly. In the frequency extender, the 10 MHz standard signal is used to phase-lock a 10 MHz varactor-controlled crystal oscillator. The output from this oscillator is used in the extender to provide the reference frequency for phase-locked tuning of the variable local oscillator, and to phase-lock both the 200 MHz standard output generator and the 2 GHz fixed local oscillator. The 10 MHz varactor-controlled crystal oscillator provides isolation and suppression of noise between the spectrum analyser standard frequency and the extender's phase-locked circuits.

200 MHz standard output generator

10. The 10 MHz reference frequency samples the output of a 200 MHz varactor-controlled oscillator. If the 200 MHz signal is not an exact multiple of the 10 MHz reference frequency, an error voltage is produced which changes the bias voltage on the oscillator's varactor diode, thus maintaining the frequency at 200 MHz. The phase-locked output of the 200 MHz oscillator is fed to the calibration generator where it is clipped to produce a precise 0 dBm output from a 50 Ω source impedance at the front panel standard output connector.

Fixed local oscillator

11. The 200 MHz signal which feeds the calibration generator is also fed to the fixed local oscillator. The 2 GHz output of this oscillator is phase-locked to the 200 MHz signal.

Variable local oscillator

12. In the continuously variable mode, the variable local oscillator frequency is proportional to the amount of control current fed to its main tuning coil. The current to frequency characteristic of this YIG oscillator is very linear, the conversion factor being approximately 21 MHz/mA. The control signal has two parts : a ramp waveform, which is fed from the spectrum

analyser via the horizontal scale switches, and d.c. from the reference frequency potentiometer.

13. In the phase-locked mode, the frequency of the variable local oscillator also depends on the reference frequency control setting, but is rounded to the nearest multiple of 10 MHz. When the approximate tuning has been established by the YIG oscillator main coil, driven by the reference frequency control circuit, a fine-tuning coil, fed from a phase-locked loop, tunes the YIG oscillator to the nearest harmonic of 10 MHz.

10 MHz phase-locked loop

14. The 10 MHz reference frequency, which is derived from the spectrum analyser's standard output, provides the 10 MHz intervals for phase-locking. An output from the reference frequency oscillator (see para. 6) operates a narrow-pulse generator at the 10 MHz rate, producing a broad band of 10 MHz harmonics. A difference frequency, produced by mixing outputs from the variable and fixed local oscillators is compared in a sampling gate with an adjacent 10 MHz harmonic. The resulting error current fine-tunes the variable local oscillator, so that its frequency is a multiple of 10 MHz. A variable-gain amplifier automatically adjusts the gain of the phase-locked loop so that it responds uniformly throughout its frequency range.

Tracking generator

15. The tracking generator works in a similar manner to the receiver part of the frequency extender. The tracking output from the spectrum analyser, which is nominally 80 MHz, is fed to the frequency extender where it is mixed with the 2 GHz fixed local oscillator signal to produce an intermediate frequency of nominally 1.92 GHz. The variable local oscillator frequency sweep is mixed with the 1.92 GHz intermediate frequency to produce an output frequency that tracks with the tuning of the extender.

16. When the horizontal scale is 5 MHz or less, and the spectrum analyser's local oscillator system is swept instead of the frequency extender's variable local oscillator, the spectrum analyser produces an output sweep from its tracking generator.

This sweep is translated in the frequency extender by a fixed frequency that is determined by the setting of the extender's reference frequency control. This enables all sweeps, whether or not they originate in the frequency extender's local oscillator to be tracked by the frequency extender's tracking output.

Output to counter

17. The frequency extender output that is fed to the spectrum analyser frequency counter is derived from the extender's tracking generator output.

Because the tracking generator output always tracks with the input frequency of the extender (unless the counter is switched off at the spectrum analyser COUNTER ON/OFF switch), all modes of frequency measurement, past centre, bright line and difference mode are available throughout the range of the extender. The counter input signal may alternatively be fed directly from the tracking output of the spectrum analyser, by operation of either the USE TF 2370 or MEASURE TF 2370 push-buttons which are located on the frequency extender front panel. The spectrum analyser tuning may therefore be checked without the need to disturb any of the connections between the units.

Band mask

18. Spectrum analyser tuning is also aided by the band mask facility. A signal derived from the spectrum analyser tracking output is fed in the frequency extender to a 55 MHz to 105 MHz band-pass filter. A detector converts the output from the filter to a d.c. control signal which, if it is below a preset threshold, provides a signal that switches on a 100 kHz oscillator. When the tracking output of the spectrum analyser is outside the range 55 MHz to 105 MHz, the 100 kHz oscillator produces a signal which is fed to the display section of the spectrum analyser. The level of this signal is such that it blanks the part of the display that is outside the range 55 MHz to 105 MHz, indicating that the spectrum analyser reference frequency should be adjusted.

IX 23/3

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